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in nature from thought and more real than it, but simply other experience than that which constitutes the reality of the thought.

There is one objection to the theory to which I am concerned to reply in closing. I shall be told that this theory may be all very well as psychology, but that it never will do in epistemology. You are able, it will be said, to construct this skeptical theory only because you as critic conceive yourself outside the mind and looking on, conceive yourself beholding both the memory and the past experience, both the perception and the thing-in-itself. If you too were dependent for your knowledge upon the subjective states which are all you will admit to be immediately given, the complete uncertainty of anything beyond them would reveal itself clearly, and your theory go to pieces.

To which I reply, that I as critic learn of *my relation to* past experiences and to other minds solely by means of the subjective states which I attribute to naïve knowers. But the practical habit of the race, the instinct of acting and thinking as if we had to do with an independent reality, is strong in me, and it makes that experiencing into knowledge. And the James-Miller theory is simply, as it seems to me, the correct analysis of the experiencing, with the refusal to renounce this immemorial habit of the race.

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A STUDY OF INTENSIVE FACTS

IN the preceding paper[1] we discussed some of the definitions of intensity given by authorities, and learned that its characteristics were, the property of being greater, less or equal, and the inapplicability of addition and the whole-part relation. But since we had not shown why some facts *can* be thus described and others obviously *can not,* it seemed that we had not gone to the root of the matter. Our definition remained a mere subjective group of categories which apparently could apply anywhere we pleased. We had not yet by study of the facts discovered that property peculiar to each and every actual intensity which allows to it magnitude and denies it the whole-part relation. To this study of cases, the second part of our task, we now proceed.

We begin with time. I try to show that it is a genuine intensity, and that the reason lies in that property, peculiar to time, of being a series of individual moments which can not recur—or, to put it in one word, that it is transitive. I then go on to show that every intensive fact has this same temporal property, and, therefore, that the source of the intensive characteristics lies in their temporal or transitive character. As space is the empirical criterion of extensive quantity, then, so time will be that of intensive quantity.

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[1] JOURNAL OF PHILOSOPHY, PSYCHOLOGY AND SCIENTIFIC METHOD, Vol. I., No. 9.

Time, then, is to be shown to satisfy the above definition of intensive quantity. The argument will be first that in actual time-measurement we *use* none but ordinal notions, and second that no whole-part relation, no addition, in short, no notion of extensive quantity is *implied.*

When we measure a time-length we make use of some process which is repeated continually: the revolution of the earth about its axis, the repeated journey of the clock's hands, the swing of a second-pendulum. We express the amount of time-length by saying (for example) 'it occupied 50 seconds,' that is, 50 repetitions in order of a certain standard process. Now the first thing that strikes one here is that nothing is said about the length of each repetition. Each swing might be longer than the last if the other processes in the world lengthened correspondingly, and it would make no difference to our calculations. Now if the amount of time-length is indifferent it shows that it is useless (though of course not necessarily erroneous) to consider it at all. The needs of scientific prediction are satisfied without our believing in the absolute equality of all the cases in the series, for we do not want to predict *how long* we shall have to wait for a given event to occur, but only *at which repetition,* in the future, of the standard process, the event in question will occur. Nor is the matter altered when we consider the agreement of independent time-keepers. If the different series of events only continue uniform with respect to each other, science can predict just as well. For that is all that agreement of independent time-keepers means. If the clock ticks just as many times one year as the next, it simply means that the stages in the motion of the earth can be exactly correlated with those of the clock-hands, and if all the independent cyclic processes agree, it simply shows that they all keep step together,—it does not show that the stride is not lengthened or shortened. It is often said[2] that we have to assume uniformity to measure time; but it is not uniformity within any one series—only between various independent series. 'Absolute time,' says Professor Mach,[3] 'has neither a practical nor a scientific value,' and if here we mean absolute quantity of time in the extensive sense we must certainly agree. At the same time one might, with Mr. Russell,[4] regard time as absolute, though only as an order. At any rate, 'the question whether a motion is itself uniform' is, if not 'senseless,'[5] at least useless. Equal times for science mean the same process or the same number of repetitions thereof. Actual time-measurement, then, does not make use of the notion of absolute equality; it uses only ordinal notions. However, as we shall see, equality is quite possible in a purely ordinal series, and for psychological reasons must be admitted to time-lengths. I wish only to point out at present how far scientific measurement of time, which is supposed usually to imply that it has the properties of extensive quantity, actually is from doing this.

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[2] Cf. E. H. Rhodes, 'The Scientific Concept of the Measurement of Time,' *Mind,* X., 347.

[3] 'Science of Mechanics' (Eng. transl.), p. 224.

[4] 'Is Position in Space and Time Absolute or Relative?' *Mind,* N. S., 10, 293.

Nevertheless the objection seems inevitable that we have in the *number* of repetitions a divisible quantity just as much as in space; that we have been surreptitiously using the idea of extensive quantity; that even in saying it did not matter whether the earlier cycles equal the later in length we had to speak as though all of them had *some* amount, though we could not determine that amount. So we must now ask: even granting that we use explicitly no other ideas than those of order, are not other ideas such as addition and division (wholes and parts) implied? To put it in another way: how can you define time-length except by numbers that can be added and divided?

The case of time-length differs from that of the length of a straight line in space in that all the elements of the latter coexist, while in time this is not so. The past does not coexist with the present. One might go so far as to admit that many facts or events which have gone into the past can be recalled in memory, or even can be repeated existentially. But at any rate a past moment (considered separately from the event in that moment) can not itself be recalled. Otherwise it would be meaningless to say that time is an irreversible series. We doubtless have present ideas (memories) that refer back to past events, but we can not go back to the real past. Now this is the reason why time can not be an extensive quantity like space: because you can not have a whole of parts unless the parts are all there to make up the whole, and by definition this is not so in time. And here is where a time-series differs from the ordinal numbers. The latter are coexistent, for you presuppose that you can survey them in reverse order, and it is for this reason that the commutative and associative laws can be proved by their aid. But the commutative law can not be proved of a series of moments in time, just because you can not reverse the order. And if so, addition is impossible, and with it the kind of measurement applied to extensive quantities. I do not deny that time-measurement is possible. It is, however, a measurement like that of degrees of loudness or of any qualitative difference. It is the correlation of time-lengths with the whole numbers, with the restriction that the former are not, like the latter, divisible or addible. Thus, we can say four days are twice as long as two days if we mean only that a certain process repeated four times is that same-process-twice-repeated twice repeated. Logically we can not without contradicting the meaning of pastness go any further. A time-length, then, is to be defined as the relation between one moment and a later moment, which conforms to our definition of intensity. It has greater, less and equal (for our immediate judgments of time-perception, especially in rhythm, show this); it is apprehended all at once, when the length is completed; it is not a whole of parts, nor can it be added to make a whole; it can, however, be as exact as you please, for it can be correlated with ordinal numbers as regards its value. Exactness, however, by no means implies addition, multiplication or division. Its value is defined by the ordinal number of standard events between two terms.

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[5] 'Science of Mechanics' (Eng. transl.), p. 224.

Mr. Russell[6] says that by a simple convention we can extend addition to all magnitudes, intensive or otherwise. The convention is that in the series $a_0a_1a_2$, etc., where all the terms are an equal distance apart, a_0a_n is n times a_0a_1. And it is just this convention we should have to make in the case of time-lengths. But we must remember that here it is not merely a convention, but a convention that is not directly true of time.

It will be seen from the above account that the reason time is not an extensive quantity lies in its property of vanishing or its transitiveness. In a whole each part has, by the commutative law, the property that it may be taken after or before *any* other part, so long as it is taken but once. In an ordinal series, each element is, as regards its place before or after any other, individuated. Thus in extensive quantity the part or element is in respect to place universal; in order, individual. To get from one moment in time to another we must go in a determined order through certain moments and no others. Time is thus an individuated series, and any time-length is a relation defined in terms of individual elements. This is why one time-length can not become part of another. It is only analogy to call three days part of a week—analogy because the ordinal number three can, by virtue of the coexistence in ordinal series in general, be viewed as part of the number seven—no more than analogy, because time differs from the ordinal numbers in not permitting coexistence. The criterion, then, which enables us to assert that time possesses the properties of an intensity, is that it is made up of individuated elements, that no one, and no group, of them, can, after it has occurred, be used again to form part of another group, or, to put it most briefly, that it is a transitive fact. Either of these criteria—individuation or transitiveness—might serve as the criterion of intensity, but on account of its obviousness to inspection I prefer the latter.

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[6] 'Principles of Mathematics,' Vol. I., pp. 180, 181.

The reason velocities are intensities is because their value depends on time-length. A body moving at a certain velocity does not contain slower velocities, because it is an event occurring at one individual moment, or group of them; if it is increased in the latter portion of its journey, that does not contain the earlier and lesser velocity because that actually can not be repeated, since the time can not be repeated—though another equal to it may be. One velocity to contain others would have to contain other time-factors than its own, which is, as we have seen, impossible. Five miles an hour does not contain (or, since velocity is inversely as the time, we had better say is not contained in) five miles in two hours, because the journey in the one hour is not a part of that in two hours; it is a distinct individual event, and indeed this is shown by the fact that it can not occur in the same body, but requires another individual body. That is, you can not have two different velocities at once in one body because they imply different time-values at once, which is impossible. Of course we can and do measure velocities just as we do times, but this is only correlation with ordinal numbers, with the added restriction of the whole-part relation. The criterion, then, which enables us to prove that velocities are intensive quantities is that they depend upon time—which means in the last analysis that they are transitive facts.

Our study of the nature of time enables us to infer that anything which is defined in terms of tendency to change, must possess the properties of intensity. Any factor in the physical world which sets up change must be viewed as the first term in a series; and the value of that factor is expressed by the number of changes which follow from it. But it is individually different from the series to which it gives rise; and the reason it is thus individuated is because it is essentially earlier in time. The initiation of the series can not be found over again later in the series; the cause can not be part of the effect, for it is individuated in time. Of course it may be measured by correlation with the ordinal numbers, and by Mr. Russell's convention (referred to above), but this does not obliterate the fact that the whole-part relation is intrinsically impossible.

Let us apply this to temperature. The temperature of a body tends always to decrease; everything cools off. Whenever there is a transfer of heat energy it is because of a difference in temperature between two bodies; and the greater the difference the more energy is transferred (other factors being equal). Temperature differences are thus definable as initiations of a process of change; *i. e.,* transfer of heat energy. The higher temperature in one of the bodies in such a case as this, marks the first stage in the transfer; it does not contain existentially the lower one, just because they belong, in the scientific description of the phenomenon, later on in the series. Here, therefore, it is the transitiveness of the higher temperature, its character as initiator of change, that individuates it, and rules out the whole-part relation.

The other physical intensities all have the above property of setting up a series of changes, as Professor Helm[7] has shown, followed by Professor Ostwald.[8] So we seem to be justified in concluding that in the physical field whatever is transitive must possess the properties of intensity, if it has at the same time quantity.

We come now to psychical intensities. It is generally admitted that psychical states are essentially transitive, that this is perhaps their *differentia.* In the physical world we suppose the same conditions to recur: bodies are relatively permanent and distances and positions in space remain the same. But every moment of psychic life is a new entity, and a psychical state is a changing thing. Possibly in this change the same elements may recur in part, and possibly there is in some cases extensive quantity, where you have complex states with distinguishable component elements. But in the kind of psychical states to which the term intensive is applied, there is not complexity, either for immediate introspection or for definition. In a very loud tone-sensation lesser ones are not discernible; experience does not give us the parts spoken of in Mr. Stout's definition. And as Professor Münsterberg shows,[9] it is unintelligible to speak of them, for they must be identical in nature, and it is absurd to speak of such an element being present many times all at once. A psychical intensity difference is a difference between simple facts. But if so, it is intensities that are *par excellence* transitive; because one can never recur a second time as part of another greater one. An intensity has the same property as an event in time—two of the former can not coexist unless they are differently localized, just as two events can not coexist in time unless they occur in different places. In other words, it is because different intensity values of the same quality are transitive with reference to each other—because one must go before another can come—that the whole-part relation is impossible.

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[7] 'Die Lehre von der Energie.'

[8] 'Naturphilosophie,' Lect. XII.

[9] 'Grundzüge der Psychologie,' Vol. I., Ch. 8, I.

The measurement of these intensities is similar to that of time. We can immediately perceive the difference in loudness of two tone-sensations a_0 and a_1 to be the same in amount as that between a_1 and a_2. Then we may call the difference a_2a_0 twice that of a_2a_1. This is done in Weber's law, when we call the just perceptible differences equal. Such measurement, however, does not imply the whole-part relation.

It appears, then, that the above intensive facts owe their intensity to their transitiveness. But is this the only possible criterion of an intensive fact? Is it the only guarantee that where there is greater, less or equal, there will be no addition and consequently no whole-part relation? I think it is, and for the following reasons:

The commutative law (without which there is no addition or whole-part relation) seems able to hold only if the elements considered retain their individuality when brought into different permutations and combinations. Now we can postulate this of bodies and figures in space (though not always) and so here (usually) addition, wholes and parts are possible. The condition of no addition, etc., would then be, always, that the elements considered (some of them at least) do not retain their individuality when brought into various permutations and combinations. But this condition is equivalent to transitiveness, which can belong only to temporal facts. Therefore the temporal character (and what is involved in it) alone can be the condition of intensity. Of course it does not follow that every fact which has to be defined in temporal terms is intensive. When, however, it has the property of being greater, less or equal, it must be intensive, and guarantees the presence of pure order without extensive quantity, in the world of our experience. As space or coexistence makes possible extensive quantity, so time or succession makes possible intensive quantity.

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DISCUSSION

DR. PERRY'S REFERENCES TO WARD'S 'NATURALISM AND AGNOSTICISM'

In his interesting article on 'Philosophical Procedure with Reference to Science,' published in No. 7 of this Journal, Dr. R. B. Perry refers to Ward's 'Naturalism and Agnosticism' in terms that seem to indicate a serious misapprehension of the author's purpose. This misapprehension appears likewise to be shared by others: I have heard more than one person speak of the book with some